PRESS RELATIONS

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION
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SOME FACTS ABOUT

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HANFORD ATOMIC PRODUCTS OPERATION

INTRODUCTION

The Hanford plant, with headquarters at Richland, Washington, stands on some 600 square miles of government-owned land and employs about 8,000 people. General Electric operates the plant and its associated laboratories as a fixed fee contractor to the Atomic Energy Commission.

Started during World War II, it is the oldest plant in the world where men do what never before has been accomplished on such a large scale--the transmutation of elements. Uranium is converted to plutonium in eight huge atomic reactors. The plant now produces plutonium at a cost rate far below that attained during World War II.

A Hanford engineer has stated that "only a few years ago the present unit cost of plutonium was considered impossible".

THE PRODUCT

Plutonium is manufactured at Hanford in widely scattered component plants under strict security regulations.

Plutonium is an artificial and radioactive metallic element, a basic ingredient for the atomic bomb and a possible fuel for atomic power reactors of the future.

The transmutation of uranium to plutonium takes place in a reactor, a huge block of extremely pure graphite as large as a five-story building, enclosed in thick concrete and steel shielding to protect workers from dangerous atomic radiation.

Uranium fuel elements are inserted into horizontal tubes which pierce the reactor. There are two kinds of uranium--U-235, which is fissionable (capable of breaking in half, giving up neutrons and forming two smaller atoms of other elements) and U-238, which has the capacity of absorbing neutrons.

The transmutation occurs when inside the reactor, neutrons from the fissioning U-235 fly off at a great rate, bounce around in the graphite until they have slowed down to "thermal energies", and then, if they hit atoms of U-238, settle down to become part of new and heavier atoms.

The new atoms go through some changes, throwing out beta particles and gamma rays

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in the process, and finally adjust themselves to the greater internal weight and become atoms of plutonium--Pu-239.

To control the speed of the process and turn it off and on, "control rods" can be inserted or withdrawn through tubes in the reactors to soak up varying numbers of neutrons. A number of systems, each independent of others, has been created to shut down reactors automatically in case of a man-made or natural disaster such as an earthquake, bombing raid, or a power failure.

When they are removed from the reactor, fuel elements are a mixture of uranium, plutonium, and a variety of lighter--and highly radioactive--elements formed when the U-235 atoms split approximately in half to release neutrons.

The mixture is put through a separations process which extracts the plutonium from the uranium and other elements. Unused uranium is reclaimed and highly radioactive leftovers are stored underground.

Throughout the entire process, nearly everything has to be done by remote control and often behind thick walls of concrete with windows of thick, heavily leaded glass to keep radiation away from people doing the work.

Water is pumped through reactors by the tens of thousands of gallons per minute to carry off the tremendous heat generated. Aluminum jackets protect the slugs from corrosion by the cooling water. These are removed later as part of the separations process.

PROCESS IMPROVEMENT

Improvements in fuel, reactors, and separations processes have contributed to the reduction in the cost of producing plutonium.

Fuel Preparation

The Hanford operation is believed to have processed more uranium fuel elements than any other atomic plant in the world.

Fuel was one of the toughest problems at the beginning of the Hanford project. A simple fuel element shape was chosen--a solid cylinder eight inches long by one and one-half inches in diameter. But its manufacture was not simple. The fuel elements had to be sealed in aluminum cans to prevent cooling water from reacting with the uranium. Development of a satisfactory metal-to-metal seal was necessary between the can and the uranium so that heat produced in great quantities inside the fuel element would be rapidly transferred to the water. But the uranium was weakened and distorted by the tremendous radiation inside the reactor, and this complicated the fuel element manufacturing process.

It was soon learned that great changes take place inside the uranium metal during irradiation. The exact nature and causes of the changes were not known, however, until after a long period of research. Studies of uranium samples before and after irradiation--requiring electron microscopes, a remotely-operated metallograph, specially-developed ion-bombardment etching techniques, and other unusual equipment and methods--have built up a considerable body of knowledge at Hanford on the characteristics of uranium and the mechanics of radiation damage to uranium crystals. This research, plus improvements in fuel element manufacturing and testing techniques, has resulted in a fuel element that can stand more intense and prolonged irradiation, produces more plutonium in a single fuel element, and costs less.

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A fuel element with a new shape is now being manufactured in large quantities at Hanford--a cylinder shaped as before but with a hollow core through which cooling water can flow. This shape permits operation of the reactors at higher production rates since heat can be removed faster.

Additional experimental work is in progress with other fuel shapes, different fuel materials, new cladding metals, and new manufacturing methods.

Reactor Operation

The three original Hanford reactors, built during the World War II race to be first with the Atomic Bomb, were designed without the benefit of experience usually obtained from a prototype. Certain difficulties were built into them as a result of this complete lack of precedent or experience. By the end of the war, it was doubtful that these first plutonium production reactors could be continued in operation. However, postwar improvements in operating procedures and in the reactors themselves have enabled them to run at higher production rates in recent years than when new.

Reactors built since the war were designed by General Electric. Experience gained by operation of the old ones and a program of research and development enabled the Company to make important improvements in the new designs.

Experimental work with organic coolants, closed-loop cooling systems, pressurized tubes, and new operating techniques is in progress.

Although the Hanford reactors were built and are operated mainly to produce plutonium, they also are used in research. Special test channels are loaded with materials to be irradiated at high neutron flux, several fuel tubes have been pressurized and operate at high temperatures for other materials tests, and some samples are sealed in capsules and loaded in between fuel elements in the regular process tubes.

In addition, the Hanford reactors are used for the manufacture of radioisotopes. In 1957, for example, radioisotopes with an activity equal to 140 times the total world supply of radium were produced. Since startup, they have turned out isotopes with a total activity of over a million curies.

Chemical Separations

After irradiation, Hanford fuel elements are chemically processed to recover the unused uranium, separate and purify the plutonium, and isolate the highly radioactive fission products. This in itself is a complex industrial-scale chemical processing operation.

When General Electric became prime contractor at Hanford, a batch process was in use that removed the plutonium by precipitation after the fuel elements had been dissolved in nitric acid. The uranium stayed in solution and was stored with the fission products in the underground waste tanks. Since then, continuous-flow solvent extraction processes have been perfected and put into operation. They recover not only the plutonium, but also the unused uranium. They do this with such efficiency that only a few parts per million of the precious atomic fuel metals are not recovered. Impurities in the plutonium and uranium are present in the same minute quantities.

The wastes stored prior to adoption of the solvent extraction processes have been pumped out of the tanks and huge quantities of uranium were reclaimed and puri-

fied.

The wastes are still being worked with in the Hanford Laboratories. They contain considerable quantities of cesium-137 and strontium-90 which are potentially useful as sources of radiation for industry, agriculture, and medicine. A process is in its final stages of development to remove the cesium on an industrial scale, and other work, at a less advanced stage, is in progress with strontium. Adoption of such processes can provide a large supply of low-cost radiation sources for commercial and experimental application and at the same time may reduce the volume of wastes that must be stored permanently.

RESEARCH AND DEVELOPMENT

A multi-million dollar laboratory area was built a few years ago at Hanford and is being used to conduct studies in the fields of chemistry, metallurgy, physics, engineering, and biophysics. The new research facilities can accommodate as many as six hundred staff members. Other laboratory facilities are located at scattered points in the plant.

While most of the knowledge being developed at Hanford can be applied there, a large portion is also useful elsewhere. For example, it has been estimated that 90 per cent of the new knowledge being learned in the biology portion of the Hanford Laboratories will be or is useful elsewhere.

The Hanford Laboratories is involved in nearly every phase of research and development related to atomic energy. To carry out such an extensive program in this new field, much of the experimental equipment has been invented at the plant.

Some of this inventiveness was necessary because of the presence of radioactivity. Included in this category are remote viewing devices, mechanical hands, a microscope that is operated from outside a cell with 10-inch steel walls, chemical laboratory hoods operating with a down-draft, constant-volume ventilation system, microscopes and cameras that operate remotely under several feet of water, and devices for carrying out many other chemical and metallurgical laboratory operations behind metal shields or under protective pools of water.

Other equipment was necessary in order to measure minute quantities of radiation. Some instruments developed at Hanford can detect, measure, and identify only a few atoms of a radioactive element in a water sample. Such extreme sensitivity is needed to measure accurately the small amounts of radioactive materials released into the air, rivers, and ground water to assure that their concentrations are below the permissible limits for such releases.

Still other scientific equipment became necessary because entirely new kinds of research were undertaken. For example, the research work with uranium required General Electric scientists to learn the mechanics of radiation damage to uranium metal. Procedures were devised to enable them to make electron microscope examinations of individual crystals before and after irradiation and to measure with extreme accuracies the deformation of a single crystal in an X-ray spectrometer.

In addition, new procedures and equipment have been devised at Hanford to learn the nature and mechanism of radiation damage to living tissue.

A number of highly significant research programs are in progress at Hanford. Two are discussed below as illustrations.

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Radiobiology Program

An important research program at Hanford is in the field of radiobiology. One of the largest, best equipped and most talented biology laboratories in the western United States has been built up at Hanford for this work.

At first, the most urgent work was to define the highest doses of a variety of radioactive substances that could safely be administered to plants, animals and humans. Practically nothing was known about these materials before Hanford started operating, and the limits were based on work with radium and X-rays. An extremely large safety factor had been added to all of these limits because of the uncertainty involved. Years of extensive research at Hanford have since built up a body of knowledge that has made it possible to set realistic limits on the permissible limits of such elements as plutonium, uranium, and radioactive isotopes of iodine, cesium, and strontium.

Much work at Hanford has also been devoted to finding the relative effectiveness of various different radioisotopes in causing radiation damage and in establishing the true differences between the effectiveness of different kinds of radiation.

Extremely small amounts of radioactive substances are formed when impurities in the water of the Columbia River are irradiated when the water is used for cooling the reactors. These materials are present in such small quantities that they have no significance so far as safety of the water for drinking purposes are concerned. However, tiny river organisms absorb them, and they in turn are eaten by larger organisms. As they move through this "food chain", they become concentrated. So much research at Hanford has been centered around determining the extent to which the food chain is affected and the effects ultimately produced in the large animals at the top of the chain.

In order to learn how materials are transmitted from one form of life to another and the extent to which this process goes on, much has been learned at Hanford about the relationships of the various kinds of living things to each other. The extent to which fish move from one part of a river system to another, rodents and other land animals wander about, and waterfowl mix and travel is another field of great interest at Hanford.

A continuous biological sampling operation is carried out to be sure that the stringent controls on the spread of radioactive materials are effective. Samples of sagebrush, farm crops, river organisms from one-celled plants to fish, waterfowl, rabbits, mice, water, soil and so on are taken periodically. These are tested by fantastically sensitive instruments to measure precisely the amounts of radioactive materials that have been taken up. This work is complicated by the fact that every living thing contains some radiocarbon, radioactive hydrogen, and radium obtained from natural sources. And these natural radioactive materials are usually present in larger quantities than the artificial substances being measured.

Work is still going on in all of the radiobiology fields mentioned above, and much new work is in progress. One of the most wide-open fields being explored is in the question of exactly how radiation causes damage to living things--what chemical changes occur in a cell as a result of radiation--what happens in one irradiated cell that makes it die while another merely loses the power to reproduce and still another becomes the beginning of a cancer.

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Plutonium Recycle Program

Another significant research program at Hanford is called the Plutonium Recycle Program (PRP). As part of its contract with the AEC, General Electric started the program in 1956 to find the best means of using plutonium as an enriching agent in fuels for thermal heterogeneous power reactors.

The use of plutonium-239 as an enrichment material instead of uranium-235 would permit the operation of enriched fuel reactors without dependence on expensive uranium isotope separation facilities. It would increase the amount of energy recovered from a given amount of raw uranium and provide a way of utilizing for peaceful purposes plutonium not needed for weapons use.

Construction has started on a test reactor (the PRTR) to provide an experimental facility for the determination of a plutonium-fueled reactor's physics characteristics, the evaluation of fuel element designs, the study of reactor engineering concepts, and the operating techniques associated with the use of plutonium-containing fuels in power reactors.

The PRTR will be moderated by unpressurized heavy water, cooled by pressurized heavy water, and have a heat rating of 70 megawatts. The reactor, a pressure tube type, will employ the gas-balanced method of regulating the liquid moderator height.

Plutonium-containing fuel elements have been experimentally fabricated and tested in support of the PRTR. Half-inch diameter, plutonium and aluminum-silicon alloy capsules have been fabricated for physics tests. Plutonium-aluminum alloy and plutonium and aluminum-silicon alloy capsules have been irradiated to high burn-up without difficulty. Plutonium-containing ceramic fuel materials have also been prepared for evaluation.

With the success of this program, reactor designs using plutonium enriched fuel can be expected to be adopted throughout the world. At the same time, Hanford's chief product will become valuable as a peacetime fuel in addition to its present role as a weapons ingredient.

NEW PRODUCTION REACTOR

Congress has authorized the construction of a ninth production reactor at Hanford, to be built at an estimated cost of $145 million. This has become known as a "convertible reactor," since it is being built for production of plutonium only, but can be converted for dual use in plutonium and power production. Temporary construction on the New Production Reactor (NPR) was started on August 7, 1959. The General Electric Company is responsible for the over-all operability of the NPR and is designing the reactor. Burns and Roe, Inc., New York City, is designing the water plant and supporting facilities and Kaiser Engineers is the construction contractor. Construction of the New Production Reactor is programmed for completion in late 1962. This undertaking will be one of major construction jobs in the Northwest over the next several years.

The knowledge and lessons learned in seventeen years at Hanford have been built into the plans for the NPR by General Electric engineers. This reactor is a third generation design of the water-cooled, graphite-moderated type that was first selected when Hanford was built.

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The NPR is designed and is being built to assure the United States an adequate supply of plutonium for national defense. However, unlike the other Hanford production reactors, this "convertible model" can be adapted at some later date for the generation of electric power.

The NPR is a production facility, as distinguished from the PRTR which is an experimental test reactor built to determine the feasibility of using plutonium as a fuel for power production as a peaceful use for this material.

HISTORY OF HANFORD

Construction on the plant was started in 1943, by E. I. du Pont de Nemours, Inc. as prime contractor for the U. S. Corps of Engineers, Manhattan District. The Benton County site was selected because it was sparsely settled, there was plenty of pure, cold Columbia River water to cool reactors, and a good supply of electrical power was available.

Hanford, Washington, a village of about 400 people, became construction headquarters, and by mid-1944, its population had jumped to 51,000. At the end of construction, in March, 1945, the Hanford camp was closed down and later dismantled. Those who remained with du Pont to operate the new plant moved to nearby Richland, a city built simultaneously with the plants. Though a vast number of people helped build and operate the plant and the town, only a tiny handful of high officials knew what its product would be. It wasn't until the first atomic bomb was dropped on Hiroshima, Japan, that the secret of Hanford was revealed.

On September 1, 1946, the General Electric Company replaced du Pont as prime contractor, and on January 1, 1947, the U. S. Atomic Energy Commission took over from the Army Engineers, and plutonium manufacture at Hanford became a peace-time operation.

The original cost of the plant was $350,000,000, and an expansion program started in 1947, and completed in 1949, cost an additional $180,000,000. Another expansion program started in 1950, increased the total worth of the plant to around $700,000,000. The value of the plant was raised beyond the one billion dollar mark in 1956 when still newer facilities were completed and put into operation.